AIR FORCE

QUALIFICATION TRAINING PACKAGE

(AFQTP)

for

HVAC/REFRIGERATION

(3E1X1)

MODULE 12

PIPING/TUBING

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MODULE 12

PIPING/TUBING

Career Field Education and Training Plan (CFETP) references from 1 Apr 97 version.

OPR: HQ AFCESA/CEOT
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AIR FORCE QUALIFICATION TRAINING PACKAGES
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INTRODUCTION

Before starting this AFQTP, refer to and read the "Trainee/Trainer Guide" located on the AFCESA Web site **http://www.afcesa.af.mil/**

AFQTPs are mandatory and must be completed to fulfill task knowledge requirements on core and diamond tasks for upgrade training. ***It is important for the trainer and trainee to understand*** that an AFQTP ***does not*** replace hands-on training, nor will completion of an AFQTP meet the requirement for core task certification. AFQTPs will be used in conjunction with applicable technical references and hands-on training.

AFQTPs and Certification and Testing (CerTest) must be used as minimum upgrade requirements for Diamond tasks.

MANDATORY minimum upgrade requirements:

Core task:
AFQTP completion
Hands-on certification

Diamond task:
AFQTP completion
CerTest completion (80% minimum to pass)

Note: *Trainees will receive hands-on certification training for Diamond Tasks when equipment becomes available either at home station or at a TDY location*.

Put this package to use. Subject matter experts, under the direction and guidance of HQ AFCESA/CEOT, revised this AFQTP. If you have any recommendations for improving this document, please contact the HVAC/R Career Field Manager at the address below.

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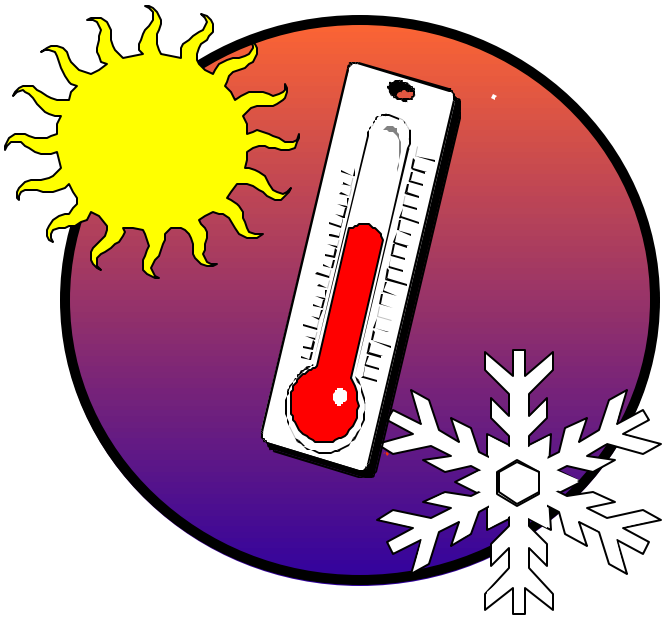
Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.



PIPING SYSTEMS FABRICATION

MODULE 12 AFQTP UNIT 4

FABRICATE PIPING AND TUBING SYSTEMS (12.4.1.)

FABRICATE PIPING AND TUBING SYSTEMS

Task Training Guide

STS Reference Number/Title:	12.4.1., Fabricate Piping and Tubing Systems
Training References:	• TR: T.O.s 34W4-1-5, --7, --8 • Cer Test video 802830, Pipe and Pipe Fitting
Prerequisites:	• Possess as a minimum a 3E131 AFSC.
Equipment/Tools Required:	• Leather Gloves/ PPE • Standard HVAC/R Tool Bag
Learning Objective:	• The trainee will know the steps required to safely fabricate piping and tubing systems.
Samples of Behavior:	• Trainee will be able to safely fabricate piping and tubing systems.
Notes:	
• Any safety violation is an automatic failure.	

FABRICATE PIPING AND TUBING SYSTEMS

Background: Different types of pipes, tubing and their associated fittings are used in the installation of HVAC/R systems. Each type of pipe, tubing or fitting is used for a specific purpose depending on the installation and its requirements. Some pipes, tubing or fittings are made in different weights and strengths for use in gravity or pressure systems. Many materials are available for use in installing permanent HVAC/R systems. Among those commonly used are iron, steel, PVC (Polyvinyl Chloride), and copper. We will discuss fabrication of piping and tubing systems.

Types of Pipe. Black iron is one type of pipe that you will be working with. This is the type of pipe most commonly used in the HVAC/R field. It is used for compressed gasses (air, gaseous fuels), steam, condensate returns and oil. Black iron pipe is not recommended for sewer lines due to rust and stoppage.

A second type of pipe that you may work with is galvanized or coated pipe. Galvanized pipe is black iron that has been dipped in a zinc bath solution. It is used for hot or cold water lines. It is not normally used for natural gas lines due to flaking action of the zinc coating.

A third type of pipe you might use is PVC pipe. This type of pipe is used for chilled water, waste water, low-temp hot water, and many other low pressure, low temp applications.

Sizes of Pipe. Sizes of pipe that you may work with range from 1/8" up to 12" (diameter). The most common sizes are: 3/8" to 2." The average length of each piece of pipe furnished to the Air Force is 20 feet. Pipe size is usually determined by the inside diameter (ID) of the pipe.

Classes of Pipe. There are three classes of pipe used in HVAC/R systems. They are:

* Standard weight (125 psi)
* Extra strength (250 psi)
* Double extra strength (600 psi)

Tubing Types. There are five main types of copper tubing. They are Type K, L, M, DWV and ACR. The classification is determined by the wall thickness

- *Type K*. A green color band along with a stencil on the tubing surface identifies tubing as type K. It is recommended for underground installation and high-pressure applications. Type K is available in a variety of sizes ranging from 1/4" to 12" in diameter and has the thickest wall of the five types.

- *Type L*. A blue color band identifies this copper tubing. It has a medium wall thickness and is recommended for interior use. Type L is also available in 1/4" to 12" diameters.

- *Type M*. Type M has a light wall thickness and is used in low-pressure installations. It is color coded red. Type M is available in sizes from 1/4" through 6" in diameter.

- *Type DWV*. (Drain, Waste and Vent). This is the thinnest wall of all types of copper tubing. It is used in non-pressure applications and is distinguished by a yellow band. This material is available in sizes from 1/4" to 6" in diameter.

- *Type ACR*. Type ACR is crimson or orange color-coded and is the same thickness as type L. The difference is it has been cleaned, dehydrated, sealed and sometimes pressurized with dry nitrogen. It is prepared for use on air conditioning and refrigeration systems.

Tubing Sizes. Copper tubing may be obtained either in hard drawn (hard temper) or annealed (soft temper). The hard drawn copper (K, L and M) is available in 20-foot lengths and annealed copper, including K, L and DWV, is available in rolls.

NOTE:
Copper tubing size is determined by the inside diameter (ID) for most plumbing type applications and outside diameter (OD) for most refrigeration and air conditioning type applications.

Fabricate Piping System.

To perform the task, follow these steps:

Step 1: Before assembling a section of pipe with a fitting, clean chips and dirt from the threads of both items with a stiff bristle or wire brush.

Step 2: Then inspect the threads to determine that they are clean and properly cut.

Step 3: Coat the male threads of the pipe evenly with pipe-joint compound or, if this is not available, anti seize (Teflon) tape may be used.

Step 4: Be sure to leave the first two threads clean. Figure 1 illustrates the application of pipe compound to a pipe.

Step 5: Start the fitting on the male thread of the pipe by hand, exercising care not to cross the threads.

Step 6: Apply a pipe wrench to the fitting and adjust for a snug fit. The pipe wrench should be placed on the shoulder of the fitting that is on the end of the fitting being connected. If the wrench is applied to any other part of the fitting, distortion of the fitting may be caused and result in a leaking joint.

Step 7: Generally, two wrenches are needed to assemble pipe, one on the pipe and the other on the fitting.

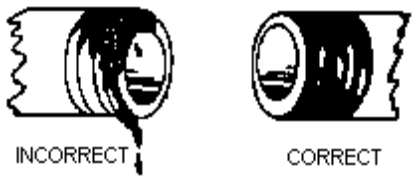


Figure 1, Application of Piping Compound

Leak Testing Piping System. Once the piping system is assembled, it should be checked for leaks. Piping systems, for the purpose of conveying water or oil, can be leak checked simply by putting water or oil pressure in the system and observing the connections for leakage.

Piping for the conveyance of natural or LP gas should be leak checked by the application of a soap solution on the connections. A leak will then be detected by the appearance of soap bubbles at the site of the leak.

Measure Tubing. Copper tubing is measured in length the same as steel or black iron pipe: end-to-end when no fittings are used; end-to-center when one fitting is used; and center-to-center when a fitting is used on both ends. Unlike steel or black iron pipe, the diameter is usually measured by outside diameter (OD). What makes a connection a perfectly airtight and watertight joint? One prime step is the correct preparation of the tubing.

Cut Tubing.

To Perform the task, follow these steps:

Step 1: The procedure for cutting tubing starts by carefully measuring for the cut.

> **NOTE:**
> Remember to allow 1/8 to 1/4 inch extra on any piece that will be flared.

Step 2: A tube cutter (Figure 2) is the desired tool for cutting tubing. Fine tooth hacksaw (32 teeth to the inch) may be used if a properly designed jig is available (Figure 3).

Step 3: A hacksaw should not be used to cut ACR tubing.

Step 4: After the tubing is cut, it is restored to its original inside diameter by using the reamer attached to the tube cutter.

Step 5: If there are any rough marks or scratches on the outside of the tubing, they can be removed with steel wool or emery cloth.

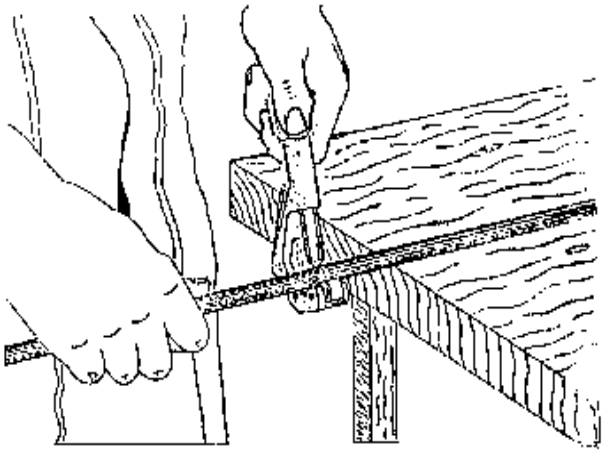


Figure 2, Tube Cutting.

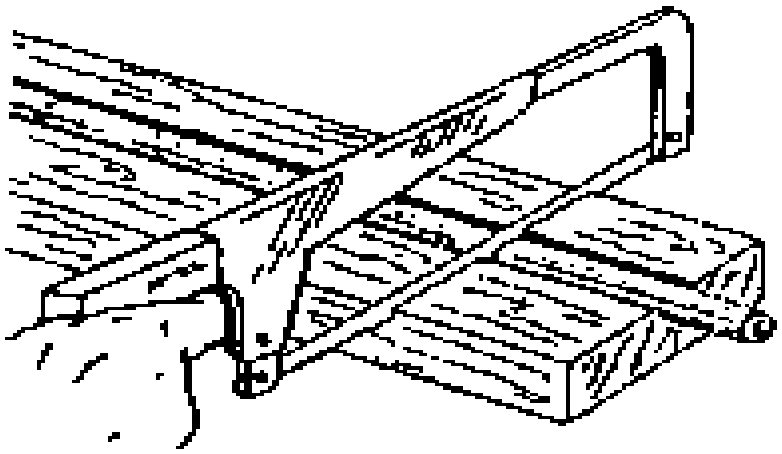


Figure 3, Hacksaw

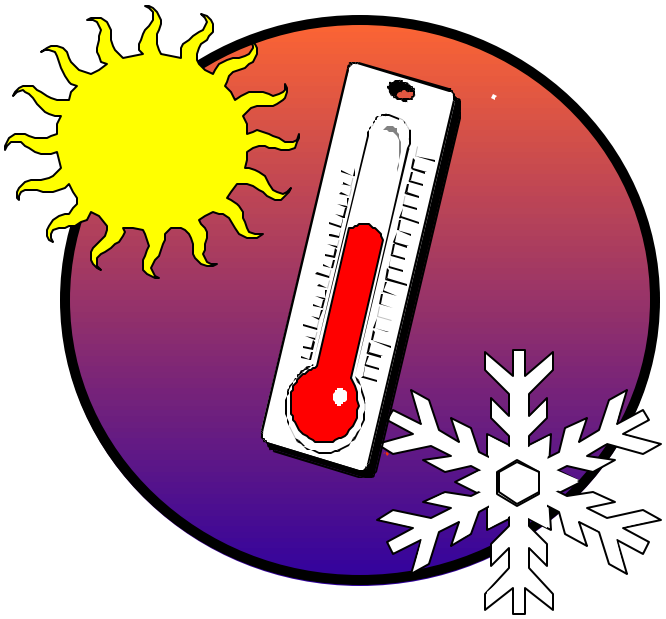
Review Questions
for
Fabricate Piping and Tubing Systems

Question	Answer
1. What are the three classes of pipe used in HVAC/R systems?	a. Standard weight (125 psi), Extra strength (250 psi), Double extra strength (600 psi). b. Standard weight (225 psi), Extra strength (350 psi), Double extra strength (800 psi). c. Standard weight (25 psi), Extra strength (125 psi), Double extra strength (400 psi).
2. What is galvanized pipe coated with?	a. Zinc bath solution b. Copper bath solution c. Lead bath solution d. Magnesium bath solution
3. What color code is used for ACR tubing?	a. Crimson or orange color-coded. b. Red-orange or maize color-coded. c. Orange color-coded only. d. Crimson color-coded only.
4. What length(s) is hard drawn copper available in?	a. 20-foot lengths. b. 40-foot lengths. c. 60-foot lengths. d. 20-inch lengths.

FABRICATE PIPING AND TUBING SYSTEMS

Performance Checklist		
Step	**Yes**	**No**
Operational Test		
1. Demonstrate Assembling a Section of Pipe?		
a. Inspect piping threads and fitting		
b. Coat male pipe threads with pipe compound or anti-seize		
c. Start fitting and adjust with pipe wrench		
2. Demonstrate Cutting Tubing?		
a. Measuring tubing for the cut		
b. The desired type of tool for cutting the tube		
c. Remove any burr's on inside of the tubing after cutting		
d. Final adjustments		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.



PIPING SYSTEMS FABRICATION

MODULE 12 **AFQTP UNIT 4**

INSTALL PIPING AND TUBING SYSTEMS (12.4.2.)

INSTALL PIPING AND TUBING SYSTEMS

Task Training Guide

STS Reference Number/Title:	12.4.2., Install Piping and Tubing Systems
Training References:	• TR: T.O.s 34W4-1-5, -7, -8
Prerequisites:	• Possess as a minimum a 3E131 AFSC
Equipment/Tools Required:	• Leather Gloves/ PPE • Standard HVAC/R Tool Bag
Learning Objective:	• The trainee will know the steps required to safely install piping and tubing systems.
Samples of Behavior:	• Trainee will be able to safely install piping and tubing systems.
Notes:	
• Any safety violation is an automatic failure	

INSTALL PIPING AND TUBING SYSTEMS

Background: Throughout your career as an HVAC/R mechanic you will be tasked with installing different types of piping systems. Different types of pipes, tubing and their associated fittings are used in the installation of an HVAC/R system. Each type of pipe, tubing or fitting is used for a specific purpose depending on the installation and its requirements. Some pipes, tubing or fittings are made in different weights and strengths for use in gravity or pressure systems. Many materials are available for use in installing permanent HVAC/R systems. Among those commonly used are iron, steel, PVC (Polyvinyl Chloride), and copper.

Types of Pipe. Black iron is one type of pipe that you will be working with. This is the type of pipe that is most commonly used in the HVAC/R field. It is used for compressed gasses (air, gaseous fuels), steam, condensate returns and oil. Black iron pipe is not recommended for sewer lines due to rust and stoppage.

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A third type of pipe you might use is PVC pipe. This type of pipe is used for chilled water, wastewater, low-temp hot water, and many other low pressure, low temp applications.

Sizes of Pipe. Sizes of pipe that you may work with range from 1/8" up to 12" (diameter). The most common sizes are: 3/8" to 2". The average length of each piece of pipe furnished to the Air Force is 21 feet. . Pipe size is usually determined by the inside diameter (ID) of the pipe.

Classes of Pipe. There are three classes of pipe used in HVAC/R systems. They are:

* Standard weight (125 psi)
* Extra strength (250 psi)
* Double extra strength (600 psi)

Measuring Piping and Tubing. There are several different methods of measuring steel piping and tubing. Among these are end-to-end measurements, center-to-center measurements and end-to-center measurements, as indicated in Figure 1.

- **End-to-End.** End-to-end measurement is measuring from one end of pipe to the other end including the threads.
- **End-to-Center.** End-to-center measurements are used when a pipe has a fitting screwed on one end only.
- **Center-to-Center.** Center-to-center measurement is from the center of the outlet on one end along the pipe, to the center of the outlet on the other end. You must always remember, the length of the thread on the pipe and the center measurement of the fittings to be used must be considered when determining the length to cut a pipe.

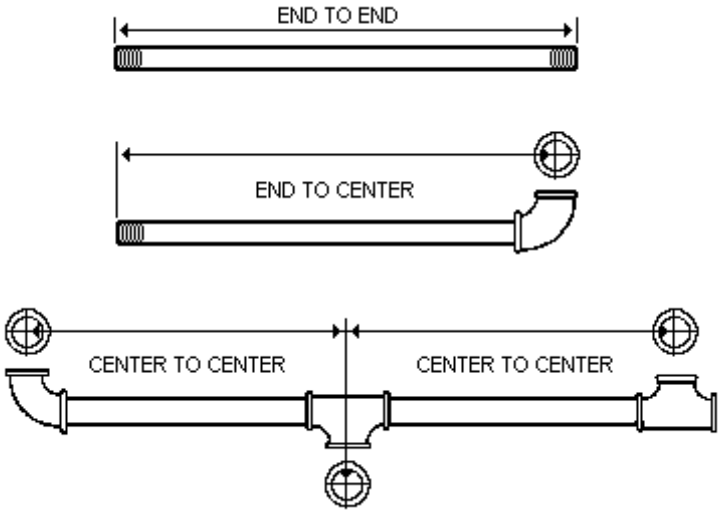

Figure 1, Measuring Steel Piping and Tubing

- **Face-to-Face.** This is a little more realistic than the other ways we've discussed. When you have a fitting at each end of a 3/4" piece of pipe, you measure from the face of one fitting to the face of the other and then you add 1" (1/2" for each fitting). This will give an accurate measurement that you will appreciate when it comes time to assemble your piping system.

Hint:
When using the face-to-face method you must remember to add more length to larger diameter pipe. Let experience be your guide.

Tubing Types. There are five main types of copper tubing. They are K, L, M, DWV and ACR. The classification is determined by the wall thickness.

- *Type K*. A green color band along with a stencil on the tubing surface identifies tubing as type K. It is recommended for underground installation and high-pressure applications. Type K is available in a variety of sizes ranging from 1/4" to 12" in diameter and has the thickest wall of the five types.

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> **NOTE:**
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Fabricate Piping System.

To perform the task, follow these steps:

Step 1: Before assembling a section of pipe with a fitting, clean chips and dirt from the threads of both items with a stiff bristle or wire brush.

Step 2: Then inspect the threads to determine that they are clean and properly cut.

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Step 7: Generally, two wrenches are needed to assemble pipe, one on the pipe and the other on the fitting.

Figure 2, Application of Pipe Compound

Leak Testing Piping System. Once the piping system is installed it should be checked for leaks. Piping systems, for the purpose of conveying water or oil, can be leak checked simply by putting water or oil pressure in the system and observing the connections for leakage.

Piping for the conveyance of natural or LP gas should be leak checked by the application of a soap solution on the connections. A leak will then be detected by the appearance of soap bubbles at the site of the leak.

Measure Tubing. Copper tubing is measured in length the same as steel or black iron pipe: end-to-end when no fittings are used; end-to-center when one fitting is used; and center-to-center when a fitting is used on both ends. Unlike steel or black iron pipe, the diameter is usually measured by outside diameter (OD). What makes a connection a perfectly airtight and watertight joint? One prime step is the correct preparation of the tubing.

Cut Tubing.

To Perform the task, follow these steps:

Step 1: The procedure for cutting tubing starts by carefully measuring for the cut.

> **NOTE:**
> Remember to allow 1/8 to 1/4 inch extra on any piece that will be flared.

Step 2: A tube cutter (Figure 3) is the desired tool for cutting tubing. A fine tooth hacksaw (32 teeth to the inch) may be used if a properly designed jig is available (Figure 4).

Step 3: A hacksaw should not be used to cut ACR tubing.

Step 4: After the tubing is cut, it is restored to its original inside diameter by using the reamer attached to the tube cutter.

Step 5: If there are any rough marks or scratches on the outside of the tubing, they can be removed with steel wool or emery cloth.

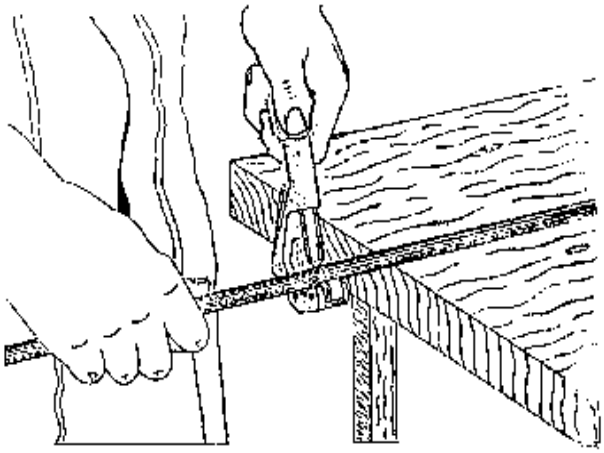


Figure 3, Tube Cutter

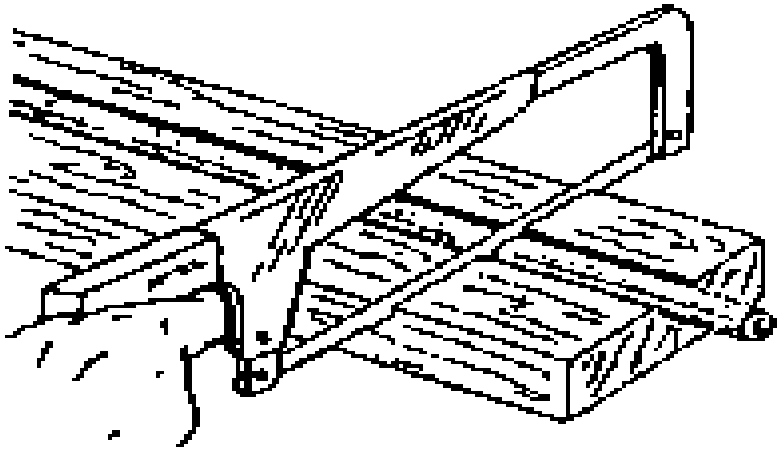


Figure 4, Fine Tooth Hacksaw

Bend Tubing. Soft drawn copper tubing can be formed into desired bends where necessary to change direction of the tubing. If care is taken, copper tubing may be bent by hand, but the slightest excess pressure at one particular point will result in a flattened or kinked tube, rendering it useless.

Hard tubing requires annealing (softening) the portions to be bent. This can be done by heating that portion of the tubing, with a torch, until it turns red. Applying cold water soaked rags to the heated portion helps the annealing and cools the tubing quickly.

Some of the methods used to bend tubing are a bending block (Figure 5) and filling the tube with sand (never use the sand method on ACR tubing), bending the sand filled tube by hand (Figure 6). The two most common methods are the spring bender and the mechanical tube bender.

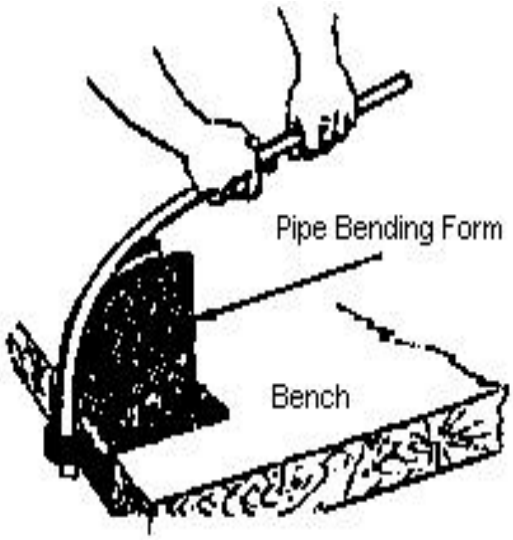


Figure 5, Bending Block

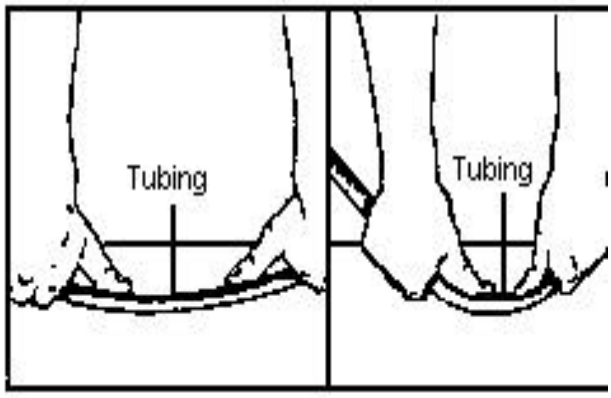
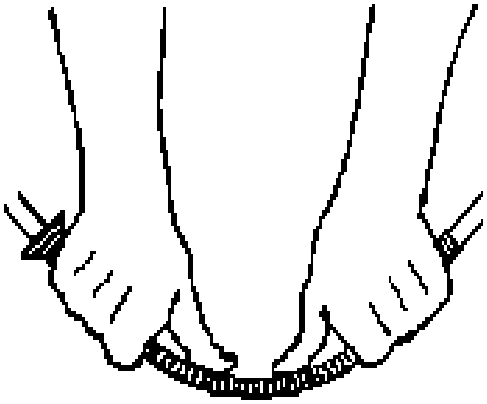


Figure 6, Sand Filled Tubing

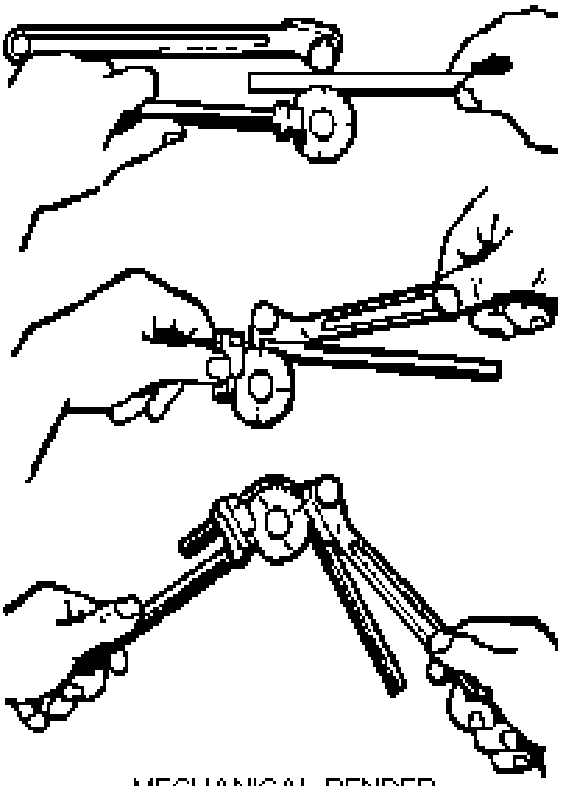
Spring Bender. Place the correct size flexible bending spring over the tubing and gradually form it with the thumbs at the same time pressing the tubing against a table or flat surface (Figure 7).

Mechanical Tube Bender. Mechanical tube benders are considered the most practical way to bend copper tubing. They are made in many sizes and designs. Figure 8 illustrates a tube bender and the steps used in bending tubing. When placing the tubing in the bender, raise the right handle of the bender as far as it will go so that it rests in a horizontal position. Raise the clip and drop the tubing in the space between the handle slide block and the bending form. (Drop clip over the tube and turn handle slide bar around the pin and press to the right.) Note that the ZERO mark on bending form will line up with the mark on the slide bar. Proceed to bend to the desired angle.



SPRING BENDER

Figure 7, Spring Bender



MECHANICAL BENDER

Figure 8, Mechanical Bender

Connect Tubing. Now that you have learned about preparing tubing by measuring, cutting, reaming and bending, it's time to discuss connecting tubing. Four ways of connecting tubing will be discussed: They are swaging, flaring, ferrule and soft soldering.

- **Swaging.** Swaging is the process by which the end of the one piece of tubing is stretched or expanded so that the end of another piece of tubing of the same size will fit into it (Figure 9). The joint will then be sealed by soldering or brazing. By swaging the use of a fitting is eliminated.

Swaging can be used in close places where there is not room for fittings. A good swage connection will reduce the possibilities of leaks.

Two types of swaging kits are the standard and the universal swaging kits.

- **Standard Kit.** The standard swaging kit consists of a swaging punch and a swaging block, as illustrated in Figure 10. The swaging punch has a small portion (called a pilot) which fits easily into the inside of the tubing, and a tapered lead which connects this pilot with an enlarged portion which is slightly larger than the outside diameter of the tube.

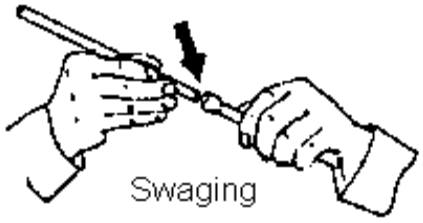


Figure 9, Swaging

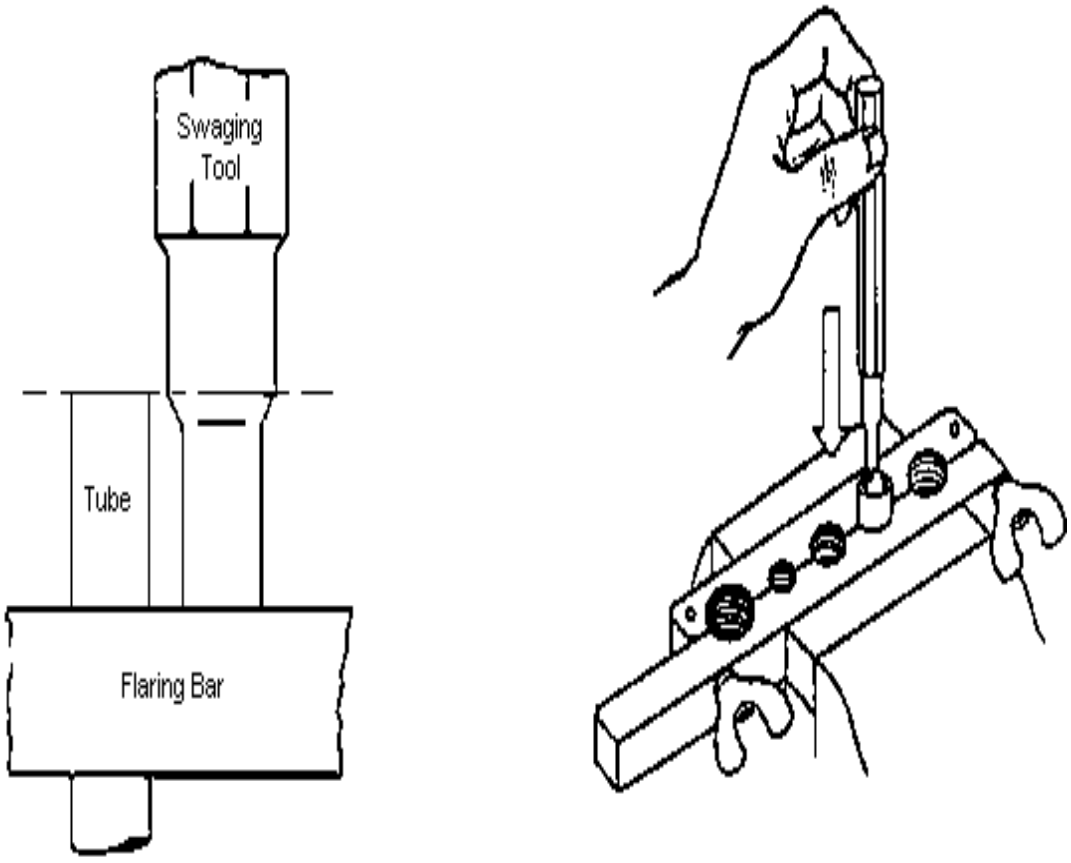


Figure 10, Standard Kit

- **Universal Kit.** The universal swaging kit consists of a conventional flaring block, swaging spreader and yoke (Figure 11). Swaging with the universal kit should be accomplished as follows:

Place tubing in a conventional flaring block and extend above the face of the flaring block approximately 1/8" more than the diameter of the tube you are swaging. (Example: 3/8" tubing + 1/8" = 4/8" or 1/2").

Tighten the flaring block down to prevent tubing from slipping. (Slippage will cause damage to tubing and swaging spreader.)

Select the proper sized swaging spreader and screw into the yoke screw. (Example: 3/8" swaging spreader for 3/8" tubing.)

> **HINT:**
> The small spreader takes care of three sizes, 3/16", 1/4" and 3/8" O.D. tubing. There is a separate spreader for every other size. Slip yoke over the bar and turn in a clockwise direction so that it hooks the bar.

Screw the spreader into the tubing (making sure to center it) until it gets to the point where the top of the upper shoulder on the spreader is bearing on the tube.

Hold the yoke so it will not twist off the bar as you unscrew the spreader from the tube.

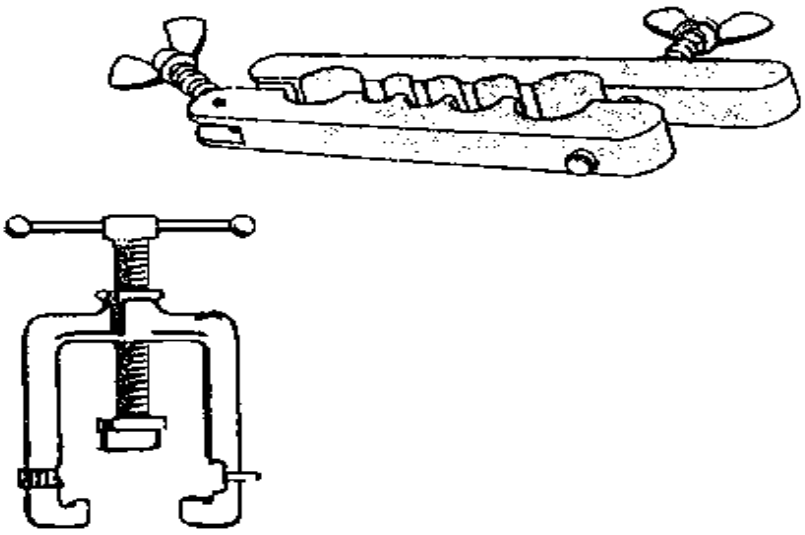


Figure 11, Universal Kit

- **Flaring.** An easy and satisfactory method of joining copper tubing is done by flaring the ends of the tubing and pressing the flared end against the tapered surface in the fittings and then screwing the flare nut tight over the end of the fitting (Figure 12).

An advantage of this type of fitting is that it is easily disassembled. This means, by using the correct size wrench, you simply unscrew the flare nut that makes up the flare-type connection, a simplified operation when it is necessary to make repairs.

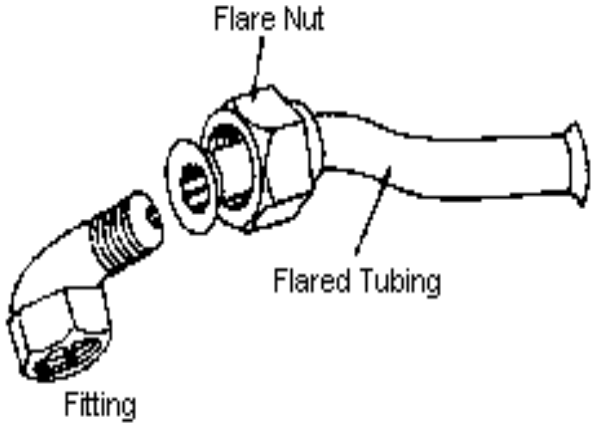


Figure 12, Flaring

To prepare the flare (Figure 13), insert the end of the tubing into the correct size hole in the flaring block and extend the end of the tubing above the face of the block double the wall thickness of the tubing. This allows enough tubing to spread over the surface of the taper on the fitting. The clamp is then attached to the flaring block and the cone is centered over the end of the tubing. The cone is then screwed into the center of the tubing by rotating the handle on the clamp clockwise. The tubing is then expanded just enough to fit into the flare nut and over the end of the fitting.

HINT:
Remember to install the flare nut before flaring the tubing.

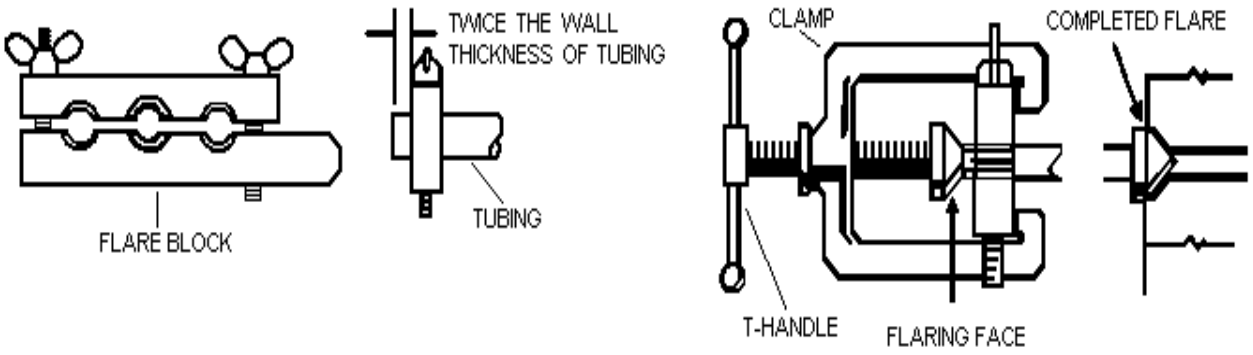
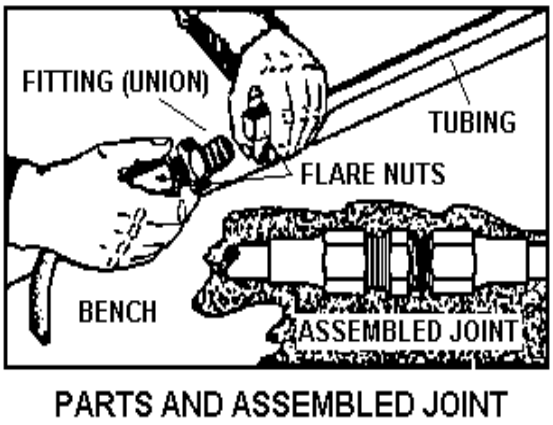


Figure 13, Flare Type Connections

After you have flared the tubing, putting the joint together is very simple. Slip the flare nut up against the flare and then screw the nut into the flare fitting, as shown in Figure 14. Use two wrenches to tighten or loosen the joint. Make sure that your wrenches fit snugly to avoid damaging the fittings. Do not use tools that will mar or scar the fittings. It is not necessary to exert excessive pressure when tightening the fittings because copper and brass are soft and contain a certain amount of lubricant that helps to seal them when a minimum amount of pressure is applied. A properly flared copper connection will withstand up to 3000 psi. A cross section view of a flared fitting is shown in Figure 15.

When you install a piping system using copper tube, there are many different types of flare fittings to choose from. You may select any combination that fits the job. Figure 15 shows a typical copper fitting that is available to you.



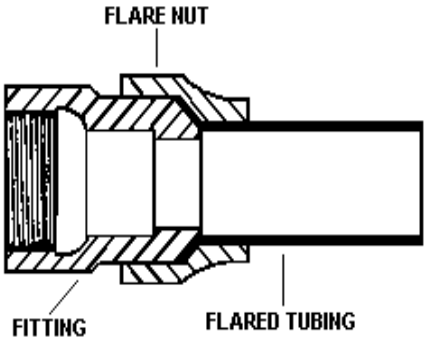


Figure 14, Parts and Assembled Joint Figure 15, Copper Fitting

Ferrule (Compression). Compression connections have three parts: The fitting, the nut and the brass ferrule sleeve (Figure 16). To make this type of connection, cut the copper tubing to the correct length. Next, ream the inside of the tubing to remove the burr. Slip the nut on the tubing first, then the ferrule. Next, slide the end of the tubing into the fitting, and slide the ferrule up against the fitting. Screw the nut onto the fitting. Use a wrench to finish tightening the nut on the fitting. Tightening the nut squeezes the ferrule into the tubing and against the fitting. This makes a watertight and airtight seal. As with flared connections, use two wrenches when assembling ferruled connections to protect the tubing from damage and prevent leaks.

Figure 16, Ferruled Connections

Review Questions
for
Install Piping and Tubing Systems

Question	Answer
1. What type of pipe does the HVAC/R technician most commonly use?	a. Black Iron b. White Iron c. Copper
2. Galvanized pipe is normally not used for _____lines due to flaking action of the zinc coating.	a. Natural Gas b. Hot or cold water c. Sewer d. Petroleum
3. How is copper tubing classified?	a. Wall Thickness b. Wood frame wall thickness c. Below sea level depth d. Plate thickness
4. Copper tubing is usually measured by_____ diameter.	a. Outside diameter (OD) for most plumbing applications and Inside diameter (ID) for refrigeration and air-conditioning applications. b. Inside diameter (ID) for most plumbing applications and Outside diameter (ID) for refrigeration and air-conditioning applications. c. Inside diameter (ID) for most plumbing applications and Outside diameter (OD) for refrigeration and air-conditioning applications. d. Outside diameter (OD) for most electrical applications and inside diameter (ID) for refrigeration and air-conditioning applications.

INSTALL PIPING AND TUBING SYSTEMS

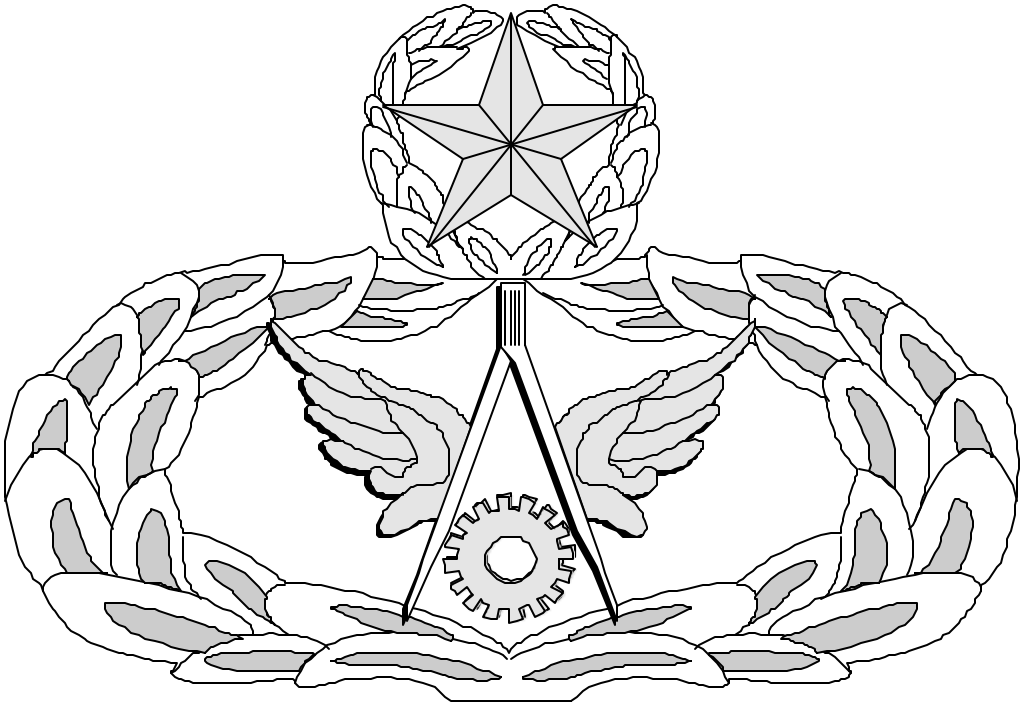
Performance Checklist		
Step	**Yes**	**No**
Operational Test		
1. Demonstrate Installing a Section of Pipe on a Fitting?		
a. Inspect piping threads and fitting		
b. Coat male pipe threads with pipe compound or anti-seize		
c. Start fitting and adjust with pipe wrench		
2. Demonstrate Swaging Copper Tubing?		
a. Correct placement of tubing in flaring block		
b. Select the proper sized swaging spreader		
c. Screw the spreader into tubing (making sure to center it)		
d. Hold the yoke so it will not twist off the bar as you unscrew		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

Air Force Civil Engineer

QUALIFICATION TRAINING PACKAGE (QTP)

REVIEW ANSWER KEY



For

HVAC/REFRIGERATION

(3E1X1)

MODULE 12

PIPING/TUBING

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training. It is to be used in conjunction with these for training purposes only.

FABRICATE PIPING AND TUBING SYSTEMS

(3E1X1-12.4.1.)

Question	Answer
1. What are the three classes of pipe used in HVAC/R systems?	a. Standard weight (125 psi), Extra strength (250 psi), Double extra strength (600 psi)
2. What is galvanized pipe coated with?	a. Zinc bath solution
3. What color code is used for ACR tubing?	a. Crimson or orange color coded
4. What length(s) is hard drawn copper available in?	a. 20-foot lengths

INSTALL PIPING AND TUBING SYSTEMS

(3E1X1-12.4.2.)

Question	Answer
1. What type of pipe does the HVAC/R technician most commonly use?	a. Black Iron
2. Galvanized pipe is normally not used for _____lines due to flaking action of the zinc coating.	a. Natural Gas
3. How is copper tubing classified?	a. Wall Thickness
4. Copper tubing is usually measured by_____ diameter.	c. Inside diameter (ID) for most plumbing applications and Outside diameter (OD) for refrigeration and air-conditioning applications.